Chapter D4: Value of Baseline I&E Losses from Four Facilities on Tampa Bay

This chapter presents the results of EPA's evaluation of the economic losses associated with I&E at four facilities on Tampa Bay: P.L. Bartow (Florida Power Corporation), Big Bend (Tampa Electric Company), F.J. Gannon (Tampa Electric Company), and Hooker's Point (Tampa Electric Company).

CHAPTER CONTENTS

D4-1 OVERVIEW OF VALUATION APPROACH

I&E at Big Bend affect commercial and recreational fisheries as well as forage species that contribute to the biomass of fishery species. EPA evaluated all of these species groups to capture the total economic impact of I&E at Big Bend.

Commercial fishery impacts are based on commodity prices for the individual species. Recreational fishery impacts are based on benefits transfer methods, applying the results from nonmarket valuation studies (EPA also conducted a primary analysis of recreational fishery benefits, which is presented in Chapter D5). The economic impact of forage species losses is determined by estimating the replacement cost of these fish if they were to be restocked with hatchery fish, and by considering the foregone biomass production of forage fish resulting from I&E losses and the consequential foregone production of commercial and recreational species that prey on the forage species. All of these methods are explained in further detail in the Chapter D3 of this document.

Many of the I&E-impacted fish species at CWIS sites are harvested both recreationally and commercially. To avoid double-counting the economic impacts of I&E on these species, EPA determined the proportion of total species landings attributable to recreational and commercial fishing, and applied this proportion to the impacted fishery catch. For example, if 30 percent of the landed numbers of one species are harvested commercially at a site, then 30 percent of the estimated catch of I&E-impacted fish are assigned to the increase in commercial landings. The remaining 70 percent of the estimated total landed number of I&E-impacted adult equivalents are assigned to the recreational landings.

The National Marine Fisheries Service (NMFS) provides both recreational and commercial fishery landings data by state. To determine what proportions of total landings per state occur in the recreational or commercial fishery, EPA summed the landings data for the recreational and commercial fishery, and then divided by each category to get the corresponding percentage. The percentages applied in this analysis are presented in Table D4-1.

As discussed in Chapters A5 and A9 of Part A, the yield estimates presented in Chapter D3 are expressed as total pounds for both the commercial and recreational catch combined. For the economic valuation discussed in this chapter, total yield was partitioned between commercial and recreational fisheries based on the landings in each fishery. Because the economic evaluation of recreational yield is based on numbers of fish rather than pounds, foregone recreational yield was converted to numbers of fish. This conversion was based on the average weight of harvestable fish of each species. Note that the numbers of foregone recreational fish harvested are typically lower than the numbers of age 1 equivalent losses, since the age of harvest of most fish is greater than age 1.

Table D4-1: Percentages of Total Impacts Occurring to the Commercial and Recreational Fisheries of Selected Species at Big Bend Facility

Fish Species	Percent Impacts to Recreational Fishery	Percent Impacts to Commercial Fishery
Black drum	55	45
Blue crab	18	82
Menhaden spp.	0	100
Pinfish	97	3
Pink shrimp	0	100
Sheepshead	84	16
Silver perch	100	0
Spotted seatrout	100	0
Stone crab	18	82

Mon Jan 28 09:01:39 MST 2002 ; TableA:Percentages of total impacts occurring to the commercial and recreational fisheries of selected species; Plant: bigbend.unit.1.4 ; Pathname: P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/TableA.Perc.of total.impacts.bigbend.unit.1.4.csv

D4-2 Economic Value of Recreational Fishery Losses

D4-2.1 Economic Values for Recreational Losses Based on Literature

Several studies provide willingness-to-pay (WTP) values for increases in recreational catch rates. These increases in value are benefits to the anglers, and are often referred to by economists as a "consumer surplus" per additional fish caught.

When using values from the existing literature as proxies for the value of a trip or fish at a site not studied, it is important to select values for similar areas and species. Table D4-2 gives a summary of two studies that are closest to Tampa Bay in geographic area and relevant species. The results of the RUM analysis (in Chapter D5) are consistent with these values ranging from $2.80 to $5.46 per added fish caught (see Table D5-12).

Table D4-2: Selected Valuation Studies for Estimating Changes in Catch Rates

Authors	Study Location and Year	Item Valued	Value Estimate ($2000)	
McConnell and Strand (1994)	Mid- and south Atlantic coast, anglers targeting specific species, 1988	Catch rate increase of 1 fish per trip[a]	small gamefish (FL) bottomfish (FL)	$8.88 $2.30
Milon et al. (1994)	Florida, anglers targeting specific species, 1991	Catch rate increase of 1 fish per trip and 1 fish every 3rd trip.	king mackerel	$5.53

[a] Value was reported as "two month value per angler for a half fish catch increase per trip." From 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S. DOI, 1997), the average saltwater angler takes 1.5 trips in a 2 month period. Therefore, to convert to a "1 fish per trip" value, EPA divided the 2 month value by 1.5 trips and then multiplied it by 2, assuming the value of a fish was linear.

McConnell and Strand (1994) estimated fishery values for the mid- and south Atlantic states using data from the National Marine Fisheries Statistical Survey. They created a random utility model of fishing behavior for nine states, the northernmost being New York. In this model, they specified four categories of fish: small gamefish (e.g., striped bass), flatfish (e.g., flounder), bottomfish (e.g., weakfish, spot, Atlantic croaker, perch), and big gamefish (e.g., shark). For each fish category, they estimated per angler values for access to marine waters and for an increase in catch rates. For this analysis, EPA used only the values McConnell and Strand (1994) estimated for Florida.

Milon et al (1994) surveyed over 4,000 anglers to ascertain their willingness-to-pay values for increases in king mackerel caught. Specifically, average catch increases from 1 fish every 3rd trip to 1 fish every trip were evaluated by the authors. The value listed in Table D4-2 is the averaged WTP value between those two scenarios.[1]

No known recreational values were located for blue crab. EPA used a value estimate in this analysis obtained by averaging the combined values of the species of fish that had been estimated from McConnell and Strand (1994) and Milon et al. (1994).

D4-2.2 Economic Values of Recreational Fishery Losses Resulting from I&E at Big Bend

Tables D4-3 and D4-4 present the loss to recreational catch from impingement and entrainment, respectively, and apply the values listed in Table D4-2 to obtain losses in recreational value from I&E at Big Bend. Total losses to recreational fisheries are estimated to be $34,100 for impingement per year, and $194,700 annually for entrainment.

Table D4-3: Average Annual Impingement of Recreational Fishery Species at Big Bend and Associated Economic Values

Species	Loss to Recreational Catch from Impingement (# of fish)	Recreational Value/Fish	Loss in Recreational Value from Impingement
Black drum	4	$2.30	$9
Blue crab	1,750	$5.59[a]	$9,782
Pinfish	2,342	$2.30	$5,386
Silver perch	40	$2.30	$93
Spotted seatrout	2,105	$8.88	$18,693
Stone crab	22	$5.59[a]	$122
Total	6,263		$34,085

[a] Recreational value used is an average from the range of all other species' values.
Mon Feb 04 2002 ; TableB: recreational losses and value for selected species; Plant: bigbend.unit.1.4 ; type: I
Pathname:
P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/TableB.rec.losses.bigbend.unit.1.4.I.csv

Table D4-4: Average Annual Entrainment of Recreational Fishery Species at Big Bend and Associated Economic Values

Species	Loss to Recreational Catch from Entrainment (# of fish)	Recreational Value/Fish	Loss in Recreational Value from Entrainment
Black drum	666,973	$2.30	$68,878[a]
Sheepshead	101	$2.30	$232
Silver perch	1,102	$2.30	$2,535
Spotted seatrout	6,794	$8.88	$60,333
Stone crab	11,227	$5.59[b]	$62,761
Total	686,198		$194,739

[a] Black drum losses are capped at $68,878, which is double the value of the mean annual 1981-1986 recreational landings (a period prior to a sharp decline in landings).
[b] Recreational value used is an average from the range of all other species' values.
Mon Feb 04 2002 ; TableB: recreational losses and value for selected species; Plant: bigbend.unit.1.4; type: E
Pathname:
P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/Capped.TableB.rec.losses.bigbend.unit.1.4.E.csv

[1] The I&E data listed in the following sections did not end up including mackerel, so these values were not applied in the analysis, but remain listed here for valuation comparison purposes.

D4-3 Economic Value of Average Annual Commercial Fishery Losses Resulting from I&E at Big Bend

Baseline losses to commercial catch (pounds) are presented in Tables D4-5 (for impingement) and D4-6 (for entrainment). Values for commercial fishing are relatively straightforward because commercially caught fish are a commodity with a market price. The market value of foregone landings to the commercial fisheries is $4,600 for impingement per year, and $260,900 annually for entrainment.

Table D4-5: Average Annual Impingement of Commercial Fishery Species at Big Bend and Associated Economic Values

Species	Loss to Commercial Catch from Impingement (lb of fish)	Commercial Value/Fish	Loss in Commercial Value from Impingement
Black drum	60	$0.44	$26
Blue crab	2,734	$0.62	$1,695
Pinfish	131	$3.18	$418
Pink shrimp	974	$2.30	$2,240
Stone crab	356	$0.62	$221
Total	4,255		$4,600

Mon Feb 04 2002 ; TableC: commerical losses and value for selected species; Plant: bigbend.unit.1.4 ; type: I
Pathname:
P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/TableC.comm.losses.bigbend.unit.1.4.I.csv

Table D4-6: Average Annual Entrainment of Commercial Fishery Species at Big Bend and Associated Economic Values

Species	Loss to Commercial Catch from Entrainment (lb of fish)	Commercial Value/Fish	Loss in Commercial Value from Entrainment
Black drum	9,918,509	$0.44	$137,756[a]
Menhaden spp.	52	$0.17	$9
Pink shrimp	4,224	$2.30	$9,715
Sheepshead	33	$0.50	$17
Stone crab	182,870	$0.62	$113,379
Total	10,105,689		$260,876

[a] Commercial value of black drum entrainment losses are capped at $137,756, which is the value of double the mean annual 1981-86 commercial landings (a period prior to a sharp decline in landings).
Mon Feb 04 2002 ; TableC: commerical losses and value for selected species; Plant: bigbend.unit.1.4; type: E
Pathname:
P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/Capped.TableC.comm.losses.bigbend.unit.1.4.E.csv

Changes to commercial activity thus far have been expressed as changes from dockside market prices. However, to determine the total economic impact from changes to the commercial fishery, EPA determined the losses experienced by producers (watermen), wholesalers, retailers, and consumers.

The total social benefits (economic surplus) are greater than the increase in dockside landings, because the increased landings by commercial fishermen contribute to economic surplus in each of a multi-tiered set of markets for commercial fish. The total economic surplus impact thus is valued by examining the multi-tiered markets through which the landed fish are sold, according to the methods and data detailed in Chapter A9.

The first step of the analysis involves a fishery-based assessment of I&E-related changes in commercial landings (pounds of commercial species as sold dockside by commercial harvesters). The results of this dockside landings value step are described above. The next steps then entail tracking the anticipated additional economic surplus generated as the landed fish pass from dockside transactions to other wholesalers, retailers and, ultimately, consumers. The resulting total economic surplus measures include producer surplus to the watermen who harvest the fish, as well as the rents and consumer surplus that accrue to buyers and sellers in the sequence of market transactions that apply in the commercial fishery context.

To estimate producer surplus from the landings values, EPA relied on empirical results from various researchers that can be used to infer producer surplus for watermen based on gross revenues (landings times wholesale price). The economic literature (Huppert, 1990; Rettig and McCarl, 1985) suggests that producer surplus values for commercial fishing ranges from 50 to 90 percent of the market value. In assessments of Great Lakes fisheries, an estimate of approximately 40% has been derived as the relationship between gross revenues and the surplus of commercial fishermen (Cleland and Bishop, 1984, Bishop, personal communication, 2002). For the purposes of this study, EPA believes producer surplus to watermen is probably in the range of 40% to 70% of dockside landings values.

Producer surplus is one portion of the total economic surplus impacted by increased commercial stocks — the total benefits are comprised of the economic surplus to producers, wholesalers, processors, retailers, and consumers. Primary empirical research deriving “multi-market” welfare measures for commercial fisheries have estimated that surplus accruing to commercial anglers amount to approximately 22% of the total surplus accruing to watermen, retailers and consumers combined (Norton et al., 1983; Holt and Bishop, 2002). Thus, total economic surplus across the relevant commercial fisheries multi-tiered markets can be estimated as approximately 4.5 times greater than producer surplus alone (given that producer surplus is roughly 22% of the total surplus generated). This relationship is applied in the case studies to estimate total surplus from the projected changes in commercial landings.

Accordingly, the total economic loss to the commercial fisheries ranges from $8,400 to $14,600 for impingement per year, and from $474,300 to $830,100 annually for entrainment at Big Bend.

D4-4 Indirect Use: Forage Fish

Many species affected by I&E are not commercially or recreationally fished. For the purposes of this study, EPA refers to these species as forage fish. Forage fish are species that are prey for other species and are important components of aquatic food webs. The following sections discuss the economic valuation of forage losses using two alternative valuation methods.

Replacement value of fish

The replacement value of fish can be used in several cases. First, if a fish kill of a fishery species is mitigated by stocking of hatchery fish, then losses to the commercial and recreational fisheries would be reduced, but fish replacement costs would still be incurred and should be accounted for. Second, if the fish are not caught in the commercial or recreational fishery, but are important as forage or bait, the replacement value can be used as a lower bound estimate of their value (it is a lower bound because it would not consider how reduction in their stock may affect other species’ stocks). Third, where there are not enough use data to value losses to the recreational and commercial fisheries, replacement cost can be used as a proxy for lost fishery values. Typically the consumer or producer surplus is greater than fish replacement costs, and replacement costs typically omit problems associated with restocking programs (e.g., limiting genetic diversity).

The cost of replacing forage fish lost to I&E has two main components. The first component is the cost of raising the replacement fish. Table D4-7 displays the replacement costs and associated baseline value losses of selected species at the Big Bend Facility. The annual costs of replacing baseline annual forage losses are approximately $100 for impingement and $6,214,100 for entrainment. The per pound costs listed in Table D4-7 are average costs to fish hatcheries across North America to produce different species of fish for stocking.

Table D4-7: Replacement Cost of Various Forage Fish Species for the Big Bend Facility (2000$)

Species	Hatchery Costs[a] ($/lb)	Annual Cost of Replacing Forage Losses	
		Impingement	Entrainment
Bay anchovy	$0.11	$42	$6,188,121
Chain pipefish	$0.34[b]	$0	$395
Goby spp.	$0.34[b]	$0	$4,020
Hogchoker	$0.34[b]	$0	$55
Leatherjacket	$0.34[b]	$0	$1,441
Scaled sardine	$0.34[b]	$2	$14,751
Searobin	$0.34[b]	$80	$5,178
Tidewater silverside	$0.11	$0	$174
Total		$123	$6,214,135

[a] These values were inflated to 2000$ from 1989$, but this could be imprecise for current fish rearing and stocking costs.
[b] Individual species value is not available and thus an average of all species is used.
Source: Sourcebook for Investigation and Valuation of Fish Kill, AFS, 1993.
Mon Feb 04 2002 ; TableD: loss in selected forage species; Plant: bigbend.unit.1.4 ; type: I Pathname: P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4/TableD.forage.eco.ter.repl.bigbend.unit.1.4.I.csv

Note that hatchery costs are not available for all I&E impacted forage species at the Big Bend Facility. Therefore, the replacement costs reflect a partial estimate only. The second component of replacement cost is the transportation cost, which includes costs associated with vehicles, personnel, fuel, water, chemicals, containers, and nets. The AFS (1993) estimates these costs at approximately $1.13 per mile, but does not indicate how many fish (or how many pounds of fish) are transported for this price. Lacking relevant data, EPA does not include the transportation costs in this valuation approach. Typically the consumer or producer surplus is greater than fish replacement costs, and replacement costs typically omit problems associated with restocking programs (e.g., limited genetic diversity).

Production foregone value of forage fish

This approach considers the foregone production of commercial and recreational fishery species resulting from I&E of forage species based on estimates of trophic transfer efficiency, as discussed in Chapter A5 of Part A of this document. The economic valuation of forage losses is based on the dollar value of the foregone fishery yield resulting from these losses.

Although this approach has shown to be an effective valuation approach for the other § 316(b) case studies, EPA concluded that this approach is not applicable to the Tampa Bay case study. Unfortunately, the species for which I&E data are available in Tampa Bay are not species that are primary consumers of the forage species impacted by I&E at Big Bend. Thus, EPA relied on the replacement cost method alone to value forage species losses in Tampa Bay.

D4-5 Nonuse Values

Recreational consumer surplus and commercial impacts are only part of the total losses that the public realizes from I&E impacts on fisheries. Nonuse or passive use impacts arise when individuals value environmental changes apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Using a "rule of thumb" that nonuse impacts are at least equivalent to 50% of the recreational use impact (see Chapter A9 for further discussion), nonuse values for baseline losses at the Big Bend facility are estimated at $17,000 for impingement and $97,400 for entrainment.

D4-6 Summary of Economic Valuation of Mean Annual I&E at Big Bend

Table D4-8 summarizes the estimated annual baseline losses from I&E at the Big Bend facility. Total impacts range from $59,600 to $65,900 per year from impingement and from $6,980,600 to $7,336,300 per year from entrainment.

Table D4-8: Summary of Economic Valuation of Mean Annual I&E at Big Bend				
		Impingement	Entrainment	Total
Commercial: Total surplus (direct use, market)	Low	$8,363	$474,320	$482,683
	High	$14,636	$830,059	$844,695
Recreational (direct use, nonmarket)		$34,085	$194,739	$228,824
Forage (indirect use, nonmarket) using the Replacement Cost Approach		$123	$6,214,135	$6,214,258
Nonuse (passive use, nonmarket)		$17,043	$97,370	$114,412
Total (Com + Rec + Forage + Nonuse)	Low	$59,614	$6,980,564	$7,040,178
	High	$65,886	$7,336,303	$7,402,190

Mon Feb 04 16:20:51 MST 2002 ; TableE.summary; Plant: bigbend.unit.1.4 ; Pathname: P:/Intake/Tampa_Bay/Tampa_Science/scode/tables.output.unit.1.4capped/TableE.summary.bigbend.unit.1.4.csv

D4-7 Summary of Annual Value of Baseline Economic Losses from I&E at Tampa Bay Facilities

Table D4-9 summarizes the estimated annual baseline losses from I&E at the other Tampa Bay facilities, using the Big Bend data. The results were extrapolated to other facilities based on operation flows (MGD). Total impacts range from $146,800 to $162,200 per year from impingement and from $17,185,100 to $18,060,800 per year from entrainment for the four Tampa Bay facilities.

Table D4-9: EPA's Estimates of Average Annual Economic Losses at In-Scope CWIS of Tampa Bay Based on I&E Estimates

Facility	Impingement Losses		Entrainment Losses		Total	
	Low	High	Low	High	Low	High
Big Bend	$59,614	$65,886	$6,980,564	$7,336,303	$7,040,178	$7,402,190
F.J. Gannon	$56,994	$62,991	$6,673,821	$7,013,929	$6,730,815	$7,076,920
Hookers Point	$3,827	$4,230	$448,134	$470,972	$451,961	$475,202
P.L. Bartow	$26,325	$29,095	$3,082,542	$3,239,633	$3,108,867	$3,268,728
Total	$146,760	$162,202	$17,185,062	$18,060,837	$17,331,822	$18,223,039

\\alexandria\project\INTAKE\Tampa_Bay\Tampa_Science\scode\extrapolation.to.other.facilities\Chapter.B4\average.annual.econ.losses.xls 2/7/2002 (CAPPED)